DEPARTMENT OF THE ARMY
OFFICE OF THE DEPUTY CHIEF OF STAFF FOR OPERATIONS AND PLANS
400 ARMY PENTAGON
WASHINGTON DC 20310-0400

REPLY TO
ATTENTION
OF:

DAMO-ZS (70-16a) 29 September 1999

MEMORANDUM FOR SEE DISTRIBUTION

SUBJECT: FY99 Army Model Improvement Program (AMIP) and Simulation Technology (SIMTECH) Program Stewardship Report

1. This memorandum distributes the FY99 Army Model Improvement Program (AMIP) and Simulation Technology (SIMTECH) Program Stewardship Report. The Stewardship Report provides the status of the FY99 funded AMIP and SIMTECH projects and the benefits that the Army realized from them.

2. The Management Decision Package (MDEP) MS4D distributes the funds for the AMIP and SIMTECH projects. The AMIP directly support the technical Model and Simulation (M&S) standards development goals of the Army. Each fiscal year, the Army's Standards Category Coordinators nominate M&S projects that will further their standards category's standards development objectives. The SIMTECH Program focuses on accelerating the development of emerging technologies that show promise for improving the art and science of modeling and simulation (M&S). This program also seeks to develop technologies that show potential for supporting the Army's M&S standards development objectives.

3. The AMSO POC is MAJ Patrick J. Delaney, (703) 601-0012/13, extension 13 (DSN 329), e-mail: Patrick.Delaney@hqda.army.mil.

WENDELL H. LUNCEFORD, JR.
Director, Army Model and
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Enclosure
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FY99 AMIP and SIMTECH STEWARDSHIP REPORT

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FY99 AMIP and SIMTECH STEWARDSHIP REPORT

1. **PROJECT TITLE**: Acoustic Modeling for Army Studies

2. **PROJECT ID**: AMIP-99-ACQ-01

3. **SPONSORING AGENCY**: US Army Materiel Systems Analysis Activity

4. **ACCOMPLISHMENTS:** In support of the Army's recognized need for an improved acoustic sensor modeling capability to represent both enemy and friendly forces in Army force-on-force models, AMSAA has been investigating acoustic models to determine a standard acoustic algorithm or set of algorithms. The proposed standard would then be included in Army force-on-force models, such as CASTFOREM. This investigation, currently in the first year of a two-year effort.

   The acoustic effort, to date, has completed discussions with key acoustic researchers and modelers as well as a compilation of a variety of acoustic models from government and industry. AMSAA has coordinated or visited the US Army Research Laboratory (Drs. Nobel, Eicke, Kolb and Price), the US Army Tank-Automotive and Armaments Command Research, Development and Engineering Center (Mr. Shalis), the US Army Cold Regions Research and Engineering Laboratory (Mr. Albert), Penn State University (PSU) Applied Research Laboratory (Dr. Swanson), and RAND (Mr. Pinder). AMSAA has obtained the ARL ABFA, ARL SCAFFIP, ARL ADM and PSU BASIS models and have documentation of the RAND and TARDEC efforts. A short review of each of these models is provided below:

   ABFA (ARL Acoustic Battlefield Aid) - Multi-function acoustic application (multiple propagation, turbulence, terrain effects, and sensor system functions); produces propagation loss, Signal-to-Noise Ratio (SNR), probability of detection, and location accuracy estimates; inputs include scenario location, target set, meteorological conditions and sensor characteristics; requires MATLAB software.

   SCAFFIP (ARL Scanning Fast Field Program) - Generates transmission loss as function of range and frequency; complex model; long run time; contained within ABFA.

   ADM (ARL Aural Detection Model) - Current HRED ground vehicle aural detection model; uses fast heuristic to model 1/3 octave band propagation; approved Army aural non-detectability model; comparisons with ABFA planned.

   BASIS (PSU Battlefield Acoustic Sensor Integration System) - Compendium of acoustic programs -- integrates environment & sensor configuration; requires Penn State support; model capability included in ABFA.

   Rand Acoustic Effort - Limited application of BASIS, tailored to Janus ADAS/EFOG-M systems in North Korean Scenario; broader capability that addresses a larger target set, a wider range of meteorological conditions and sensor design aspects is desired.
   ICHIN 6 (NASA I Can Hear It Now, Version 6) - 1986 rotary wing acoustic detection model;

used by Sikorsky for Comanche effort; comparisons with ABFA planned.

5. **LESSONS LEARNED**: None.

6. **BENEFITS TO ARMY**: The direct and immediate benefit is to enable the inclusion of explicit modeling of a relatively new technology (acoustic sensors) in Army analyses at an adequate level of fidelity to support assessment of the impact of these systems.

7. **WORK REMAINING TO BE COMPLETED**: Through the end of this fiscal year, this effort will complete a more detailed comparison of several of the leading models. The results from this comparison are expected to allow selection of a better method/process for representing acoustic capabilities in CASTFOREM.

   The second year of this planned 2-year AMIP effort will be devoted to development of the methodology for integrating the proposed standard algorithm or acoustic representation process into CASTFOREM as well as verifying/validating the acoustics modeling capability and limitations.

8. **SCHEDULES WITH MILESTONES**: (for the second year effort):

Q1-Q4:	Algorithms incorporated into force-on-force model. Input data developed/obtained. Verification/Validation of model performed.
Q3-Q4	Comparison of Algorithms to Standard Sensor Object. Coordination with SC Object Management and SC Data

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FY99 AMIP and SIMTECH STEWARDSHIP REPORT

1. **PROJECT TITLE**: Radar and Contrast Model Identification and Standard Development

2. **PROJECT ID**: AMIP-99-ACQ-02

3. **SPONSORING AGENCY**: U.S. Naval Postgraduate School,

4. **ACCOMPLISHMENTS:** The standard algorithms for **VISUAL CONTRAST MODEL** has been submitted to SNAP, a standard **RADAR DETECTION MODEL** has been drafted and is in review at the SC Acquire working group. The US Airforce Electro-Optic Tactical Decision Aid (EOTDA) has been evaluated as a thermal signature model but found to be more complex than desired for integration into a combat simulation and would be best used as an offline data generator, an alternate model is being sought.

5. **LESSONS LEARNED**: NA

6. **BENEFITS TO ARMY**: Complete standards in several areas currently widely encountered in combat simulations.

7. **WORK REMAINING TO BE COMPLETED**: A search for a thermal signature model that corresponds to the **VISUAL CONTRAST MODEL** in complexity will be continued. If a candidate is not found than a standard will be drafted around the use of the EOTDA model as a data generator for combat simulations and will be submitted to SNAP.

   A draft standard on Radar Signature Modeling citing sources of radar signature data, completeness of the data set, RF band, target set, and clutter set remains to be completed, and submitted to SNAP

   The **VISUAL CONTRAST MODEL** and **RADAR DETECTION MODEL** draft standard will need to complete the standards approval process.

8. **SCHEDULES WITH MILESTONES**:

   Q4 FY99 **RADAR DETECTION MODEL** submitted to SNAP
   Q2 FY00 Thermal Signature Model draft standard submitted to SNAP
   Q3 FY00 Radar Signature Modeling draft Standard submitted to SNAP

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FY99 AMIP and SIMTECH STEWARDSHIP REPORT

1. **PROJECT TITLE**: Compendium of Aggregate Level Attrition Algorithms

2. **PROJECT ID**: AMIP-99-ATT-01

3. **SPONSORING AGENCY**: US Army Materiel Systems Analysis Activity

4. **ACCOMPLISHMENTS**: Progress on the compendium has been slower than originally anticipated due to commitments to other projects. Thus far, however, an introductory chapter and a draft of the direct-fire attrition methodology for the DIVLEV chapter of the compendium have been completed, and sent out for review and comment. Included in the DIVLEV chapter are detailed descriptions of the preprocessed one-on-one kill rates, the isolation of direct-fire battles, target allocation, and the resulting damage. An example of this entire attrition process is also included.

5. **LESSONS LEARNED:** None.

6. **BENEFITS TO ARMY**: These attrition algorithms will be proposed as standards for use in future aggregate level simulations for distributed environments, and will provide direct input as nominations to SNAP and ASTARS.

7. **WORK REMAINING TO BE COMPLETED**: Much work remains on this project in order to produce a complete compendium. TRAC/FLVN (for the VIC simulation) and CAA (for the COSAGE/ATCAL/CEM simulation) will document their direct-fire algorithms. In addition, all three organizations will document algorithms for aggregate level attrition in the following areas: ground-to-air, air-to-ground, air-to-air, indirect fire, and minefields. No future AMIP funding will be required as the compendium will be completed using mission funds.

8. **SCHEDULES WITH MILESTONES**:

Meeting to discuss progress to date and guidelines for completion	Aug 99
Draft of entire compendium complete	Oct 99
Review and modify compendium	Nov 99-Jan 00
Final version compendium published	Feb 00

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FY99 AMIP and SIMTECH STEWARDSHIP REPORT

1. **PROJECT TITLE**: C4I Interface Data Interchange Format Development

2. **PROJECT ID**: AMIP-99-C4I-01 (was AMIP-99-VIS-01)

3. **SPONSORING AGENCY**: TRADOC/National Simulation Center

4. **ACCOMPLISHMENTS**: A contract was awarded to AB Technologies for the execution of this AMIP. The following Papers were written under this AMIP revising the C4I Interface Technical Reference Model and developing a new C4I Interoperability Conceptual Reference Model:

   Hieb & Blalock, 1999, *Data Alignment Between Army C4I Databases and Army Simulations*, Paper 98F-SIW-34, 1999 Spring Simulation Interoperability Workshop.
   Timian, Hieb, Glass & Staver, 1999, *Using Standard Components to Interface to Simulations*, 1999 Spring Simulation Interoperability Workshop.
   Hieb & Timian, 1999, Using Army Force-on-Force Simulations to Stimulate C4I Systems for Testing and Experimentation, 1999 Command and Control Research and Technology Symposium (CCRTS).
   Ressler, Hieb & Sudnikovich, 1999, *C4I and M&S Interoperability Reference Model*, 1999 Fall Simulation Interoperability Workshop, to appear.

   Two of the papers (for the Spring 99 SIW) received honors by being selected for the recommended reading list by the SIW conference Program Committee. Also Under this AMIP, the Command and Control Simulation Interchange Language was designated as a transitional standard.

5. **LESSONS LEARNED:** The C4I community has evolved separate, and often parallel, approaches to interoperability from the M&S community. As well as Data Exchange Formats, alignment between common software components and data/object models are needed to support data population, stimulation, and collection.

6. **BENEFITS TO ARMY**: The entire Army will benefit from a more rigorous description of interoperability between simulations and C4I systems. In particular, the C4I/M&S Interoperability Conceptual Reference Model is being used to identify requirements to simulation and C4I system developers as a means of achieving interoperability between their systems.

7. **WORK REMAINING TO BE COMPLETED**: Final revision of the Fall 99 SIW paper documenting the C4I/M&S Interoperability Conceptual Reference Model developed.

8. **SCHEDULES WITH MILESTONES**: Spring 99 SIW papers were completed in March 1999. The CCRTS paper was completed in May 1999. The Fall 99 SIW paper will be completed in August 1999.

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FY99 AMIP and SIMTECH STEWARDSHIP REPORT

1. **PROJECT TITLE**: Composable Behavior Representation

2. **PROJECT ID**: AMIP-99-CDM-01

3. **SPONSORING AGENCY**: Command Decision Modeling SCC, National Simulation Center, TRADOC

4. **ACCOMPLISHMENTS**: The researchers on the Composable Behavior Representation project have gathered and analyzed the doctrinal materials that describe the Army's command and control processes to be represented (i.e. FM101-5, FM 101-5-1, Operational Architecture) as well as supporting documents such as WARSIM 2000 Knowledge Acquisition papers and CGSC instructional materials. We have become familiar with the contents of the Operational Architecture (OA) and with BPWIN, the software tool used to explore the OA. We have laid out key OA diagrams showing the key commander and staff command and control functions at echelons from division to platoon and examined the processes at each level for similarities, differences and missing doctrinal materials. We have developed reports and databases describing the inputs, outputs, required resources and so on associated with the C2 processes at each echelon. We have identified doctrinal processes that are important to the simulation world.

5. **LESSONS LEARNED:** Information learned during the execution of the project that was not described in the implementation plan but would be beneficial to others.

   To develop efficient inheritance paths, you may have to start at the lowest level (perhaps squad or platoon) and build up to higher echelons (i.e., brigade) adding complexity rather than starting a higher levels and building down reducing complexity.

   There may be another way of looking at composing behaviors besides the paradigm of combining lower behaviors/processes to form higher behaviors/processes. An alternate approach may be to consider the top level process and all of its potential inputs from squad to brigade or higher in the same way that a music writer thinks of a piano. All of the inputs for a process are analogous to the piano keys and the composer (developer) uses the keys (inputs) of the piano (process) in the appropriate order to develop behaviors for the level (squad, battalion, etc) being addressed.

6. **BENEFITS TO ARMY**: The benefit of the results of this project will be a more flexible and rapid development of command and control simulations by taking advantage of the object-oriented model development paradigm. We think this effort will support the Object Management work. This effort will feed the development of behavioral object standards to be used by simulations such as JSIMS, WARSIM 2000, and OneSAF.

7. **WORK REMAINING TO BE COMPLETED**: Statement of the goals, objectives, and accomplishments remaining for completion of the project.

- Confirm or deny the relevance of the All Behavior and Trichotomy hypothesizes.
- Finish development of the proposed Composable Behavior Model.
- Prototype the Composable Behavior Model by coding lowest to highest echelons.
- Test the model at all echelons.

8. **SCHEDULES WITH MILESTONES**: Accomplished and planned, including estimated completion dates.

- Gather and analyze the doctrinal materials that describe the Army's command and control processes to be represented. **Done**
- Gain familiarity with the Army's operational architecture (OA), CGSC instructional materials and with BPWIN, the software tool used to explore the OA. **Done**
- Examine the key OA diagrams showing the key commander and staff command and control functions at echelons from division to platoon and examined the processes at each level for similarities, differences and missing doctrinal materials. **90% complete. S-31 July**
- Develop reports and databases describing the inputs, outputs, required resources and so on associated with the C2 processes at each echelon. **90% complete. S-31 July**
- Identify doctrinal processes that are not important to the simulation world. **Done**
- Confirm or deny the relevance of the All Behavior and Trichotomy hypothesizes. **S-31July**
- Finish development of the proposed Composable Behavior Model. **S-31 August**
- Prototype and test the Composable Behavior Model by coding lowest to highest echelons. **S-30 September**

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FY99 AMIP and SIMTECH STEWARDSHIP REPORT

1. **PROJECT TITLE:** Characteristics and Performance (C&P) Data Interchange Format (DIF) Development

2. **PROJECT ID**: AMIP-99-DATA-01

3. **SPONSORING AGENCY**: AMC, TRAC, CAA

4. **ACCOMPLISHMENTS**: Accomplishments to date include the following**:**

   Development of roadmap for standardization of characteristics and performance data.

   The roadmap serves as a benchmark for how standardization of the C&P data areas will be standardized. The roadmap sets for the process for mapping the data elements of AMSAA, TRAC, CAA and NGIC C&P databases.

   Development of consolidated data models for C&P data for mine systems.

   Completed data modeling of AMSAA, TRAC and NGIC C&P data elements in the air defense, armor, aviation, infantry and mine areas. Conducted comprehensive reviews to ascertain mapping functions and potential conflicts. Meetings in August of 1999 will finalize these areas plus artillery (conventional and smart). These meetings will result in mappings from the standard to TRAC-FLVN data elements.

   Submission of data models as standards.

   Data models will be submitted as standards as a package. This is a change from what was previously reported (see FY98 project report). The change was necessitated by the manner in which work progressed. Documentation is just beginning and will be completed by 30 October 1999. The product will be a narrative description of the standard. It will allow application developers to facilitate the exchange of data between the target data systems. The standard will be submitted to SNAP at this time.

   Development of AMSAA software

   AMSAA initiated software development for the C&P DIF. The software retrieves data from AMSAA's database and puts it in the format of the C&P DIF. Approximately, 60% of the identified formats have been coded and testing is underway (as of 1 Aug 99). The remaining items will be completed by 30 Oct 1999. The prototype software will allow AMSAA data administrators to produce reports in the prescribed formats and make them available to end users via SIPRNET. The second generation tools will allow users to download the data via web applications on SIPRNET.

5. **LESSONS LEARNED:** Differing levels of fidelity in data models require additional work prior to development of mapping functions. Any levels that cannot be resolved will require aggregation techniques to reformat the data. The standard data model should be at the

highest level of resolution of the merged models. NGIC data is available via existing network applications. Reworking their interfaces into a form desired by the other parties was deemed a lower priority. Most of the mapping task was shifted to another project which allows access of NGIC C&P database (SPIRIT) with TRAC-FLVN's Standard Nomenclature Database.

6. **BENEFITS TO ARMY**: The data models will serve as guidelines for development of software to automate the transfer of data between organizations. They will also serve as a blueprint for future database and standard algorithm construction. The software will be used for each study AMSAA services and will result in defined, consistent formats for DoD agencies requiring C&P data from the Army.

7. **WORK REMAINING TO BE COMPLETED**: Remaining work under the scope of this task proposal includes completion of data models as identified above, submission of standards, and completion of software. Full completion of all phases will take approximately 2 to 3 years.

8. **SCHEDULES WITH MILESTONES:**

Product	**Planned Date**	**Actual Date**	**Comments**
Source Lists	Dec 97	Dec 97	
Plan of Attack	Feb 98	Jan 98	
SAI Models	May 98	Aug 98 – Aug 99	Completed in phases.
Mapping Functions	Aug 98	Aug 99	Completed in phases.
SNAP Submissions	Sep 98	Oct 99	Projected

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FY99 AMIP and SIMTECH STEWARDSHIP REPORT

1. **PROJECT TITLE**: Development of an Extensible Hierarchy and Object Representation for Deployment Models and Simulations

2. **PROJECT ID:** AMIP-99-DEP-01

3. **SPONSORING AGENCY:** Military Traffic Management Command Transportation Engineering Agency (MTMCTEA)

4. **ACCOMPLISHMENTS:** Argonne National Laboratory (ANL) has completed the following:

   - The first phase of Extensible Hierarchy and Object Representation for Transportation Simulations (EXHORT) – an object-oriented code standardization for deployment simulations.

   - Representations of military and commercial transportation assets as well as military cargo and personnel.

   - The final report *Standardization of Transportation Classes for Object-Oriented Deployment Simulation* – dated August 1999.

   - Web-ready source code documentation for the Transportation Class Hierarchy (TCH).

5. **LESSONS LEARNED:** The data entered into simulation models is performed separately and in various formats. This practice results in many data inconsistencies and makes simulation integration very difficult and time-consuming. Simulations need to be reused to the maximum possible extent, and new simulations should be designed only when existing simulations cannot effectively provide DoD with the needed capability. To realize the greatest return on investment, DoD must team these simulations together in different combinations to satisfy a diverse and ever- evolving set of user needs. By using and adhering to standards, these goals can be achieved.

   Object-oriented programming languages have gained wide industry acceptance and must be used, due to greater reusability and greater compatibility with other systems.

   Using a “bottom-up” design approach for the EXHORT standardization better synchronicity with already existing military and industry accepted standardization efforts, such as CORBA, HLA, and DII COE, which utilize object-modeling approaches that create a more “top-down” design strategy.

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6. **BENEFITS TO THE ARMY:** This project supports Army efforts to pursue model and simulation interoperability and reusability benefits include:

   Reducing resources required to develop and maintain deployment models and simulations by providing a standard and consistent object/class attribute representation and behavior for all deployment model and simulation applications that rely on an underlying object representation.

7. **WORK REMAINING TO BE COMPLETED:** The following lists work to be completed:

   Standardize the code structures of discrete event, object-oriented, logistics simulations by expanding the transport-oriented objects (DODX railcars, commercial transport assets, military vehicles) developed in FY 98.

   Submit the TCH structure and final report, *Standardization of Transportation Classes for Object-Oriented Deployment Simulation, to* SNAP prior to the end of FY99.

   Design the two remaining EXHORT hierarchies that act on the transportation assets defined in the TCH ¾ the Resource Class Hierarchy (RCH) that describes the resources needed to support deployment and the Infrastructure Class Hierarchy (ICH) that deals with locations where activities are performed and with the physical infrastructure.

   Compare and match the class hierarchies of TRANSCAP, PORTSIM, CITM, and ELIST.

   Prepare Web-ready programmer documentation, a Java class package, and a final report on the entire EXHORT system at the completion of both the RCH and the ICH.

8. **SCHEDULES WITH MILESTONES:**

   - November 1999 ¾ Finish designing the entire EXHORT system (the ICH and RCH).
   - January 2000 ¾ Complete the first draft of final EXHORT report, which will include the RCH and ICH.
   - March 2000 ¾ Complete the final draft and Web-ready programmer documentation of the entire EXHORT system and the final EXHORT report.

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FY99 AMIP and SIMTECH STEWARDSHIP REPORT

1. **PROJECT TITLE:** Development of a Standard Infrastructure Data Structure and Interface for Deployment Models and Simulations.

2. **PROJECT ID:** AMIP-99-DEP-02

3. **SPONSORING AGENCY:** Military Traffic Management Command Transportation Engineering Agency (MTMCTEA)

4. **ACCOMPLISHMENTS:** Funding ($100K) for this effort did not arrive at the contractor until February 1999. To date, Argonne National Lab (ANL) has begun designing formalized data structures for infrastructure data used in several simulation models including PORTSIM (Sea Port Simulation), TRANSCAP (Transportation Capabilities Simulation), and CITM (Coastal Integrated Throughput Model). CITM development is a joint effort getting underway with the Waterways Experiment Station (WES) and MTMCTEA; PORTSIM and TRANSCAP are mature simulations approaching initial operational capability. In addition, the infrastructure data elements in ELIST (Enhanced Logistics Intra-theater Support Tool) as they pertain to the infrastructure nodes (ports and installations) are being included in the infrastructure database. To date, key infrastructure entities at seaports and army installations have been identified. Key meta-data (data about the infrastructure data) elements for using the infrastructure components in the simulations have also been identified. For example, data on routes followed by vehicles moving within ports and installations is based on data about more fundamental infrastructure elements, such as road segments and intersections. An initial concept paper on the infrastructure database design has been completed. A preliminary draft report explaining the infrastructure data structures and data elements is being written.

5. **LESSONS LEARNED:** A couple of lessons learned have emerged quickly from this project in its early phases:

   Investigation of the representation and treatment of infrastructure data in standard GIS databases and infrastructure data sources has revealed that infrastructure data as it is normally represented is not adequate to support fine-grained deployment simulations that model cargo, vehicles, and equipment at the individual item level. For models and simulations to support ITV and other army initiatives, it is essential to provide data structures for infrastructure elements at this fine-grained level of detail, as is being pursued on this project.

   Data structures and databases that are very flexible and can be built upon in an incremental way without starting from scratch are essential to support item-level simulations. Fine-grained simulations will continue to become available in the foreseeable future because of on-going advancements in computers and real-time information systems. Flexible data structures will be able to adapt to this dynamic environment.

6. **BENEFITS TO THE ARMY:** Geographical Information Systems (GIS) are used by various DoD activities as well as federal, state, and local governments to describe the various aspects of the transportation infrastructure, to include the detailed attributes of seaports, installations, and road/rail networks. Many deployment M&S use this GIS data as input information and to provide constraints to deployment capabilities. This project will develop a reusable, standard and flexible relational database structure that will allow various deployment M&S to use this data effectively.

7. **WORK REMAINING TO BE COMPLETED:** The remaining tasks are as follows:
   - Identify attributes of the infrastructure data elements.
   - Define relationships among infrastructure entities (for example, “connect” would be a relationship between two road segments that are connected).
   - Develop indices, primary keys, and foreign keys for most efficiently accessing the infrastructure data tables.
   - Build infrastructure data (relational) tables.
   - Complete infrastructure database (template) structure and complete final report.

8. **SCHEDULES WITH MILESTONES:**

   Oct 1: Complete infrastructure database definitions for PORTSIM, TRANSCAP, CITM, and ELIST (nodal).

   Nov. 1: Complete implementation of data structures in Oracle database structure.

   Dec. 1: Complete scripts to create table statements

   Dec. 1: Complete web-accessible infrastructure database

   Dec. 1: Complete final report.

9. **POINT OF CONTACT**:

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FY99 AMIP and SIMTECH STEWARDSHIP REPORT

1. **PROJECT TITLE:** Light Scattering for Wargames and Target Acquisition (LSWTA)

2. **PROJECT ID:** AMIP-99-DYN-01

3. **SPONSORING AGENCY:** Army Research Laboratory

4. **ACCOMPLISHMENTS:** The Sky-to-Ground Ratio (SGR) models have been obtained and are being individually examined for optimum integration. It currently appears that we will use the GUI from the BEWSS program, the computational engine from the CASTFOREM program, and the scenario setup and atmospheric structure from a third program FASCAT.

5. **LESSONS LEARNED:** The FASCAT program was not initially considered, but has proved to have additional resources that are useful and will lead to a more comprehensive standard.

6. **BENEFITS TO ARMY:** The final standard SGR/LSWTA program to be produced will provide uniform values to be used in CASTFOREM and BEWSS. In addition this program will be incorporated into the Tri-Service Target Acquisition Weather Software (TAWS). The overall benefit to the Army will be more accurate and comprehensive target acquisition routines for use either in a standalone mode or incorporated into high- and low-resolution wargames.

7. **WORK REMAINING TO BE COMPLETED:** The various portions of the three different codes need to be integrated. In addition, the methodology for determination of the downward irradiance and path radiance calculations remains to be examined. Current candidates are the delta-Eddington method contained in the CASTFOREM code and the 24-stream discrete ordinates method contained in the BEWSS code. When coding is complete, the final model must still be verified against the research grade AIM code.

8. **SCHEDULES WITH MILESTONES:**

Selection of method for irradiance determination	3Q FY99
Integration of codes	4Q FY99
Verification	1Q FY00
Final product/documentation	2Q FY00

9. **POINT OF CONTACT:**

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FY99 AMIP and SIMTECH STEWARDSHIP REPORT

1. **PROJECT TITLE:** 3-D Static Environments (3DSE)

2. **PROJECT ID:** AMIP-99-DYN-02

3. **SPONSORING AGENCY:** Army Research Laboratory

4. **ACCOMPLISHMENTS:** The 2-D surface layer models and the one-dimensional vertical models and have been structured into an integrated module. All available mass consistent flow models have been evaluated for technical content and a methodology for the integration of these model elements has been initiated. It has been determined that the basic methodology in the latter model is its handling of the lower boundary and that model integration will consist of utilizing the validated methodology of the surface layer model to provide the lower boundary condition for the flow, temperature and moisture fields. The current GUI for the surface layer model is suitable and adaptable for use for the extended model and permit the easy integration of other models that may use the 3DSE fields.

5. **LESSONS LEARNED:** Due to sensitivity to low level atmospheric stability the earlier mass consistent models require substantial expertise to obtain valid data.

6. **BENEFITS TO ARMY:** The final standard 3DSE program to be produced will provide non-expert users physically correct values of atmospheric data to be used in any M&S model. In addition this program will be incorporated into the Defense Threat Reduction Agency HPAC system. The overall benefit to the Army will be the ability to create fast, accurate high resolution environmental data for use either in a standalone mode or incorporated into high- and low-resolution wargames that can be altered as game conditions dictate.

7. **WORK REMAINING TO BE COMPLETED:** The integration of various portions of the three different codes needs to be completed and validated with the two independent data sets know to be available.

8. **SCHEDULES WITH MILESTONES:**

Complete model integration	3Q FY99
Verification/Validation of codes	4Q FY99
Final product/documentation	1Q FY00

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FY99 AMIP and SIMTECH STEWARDSHIP REPORT

1. **PROJECT TITLE**: Standard Scenario Mark-up Language (S2ML)

2. **PROJECT ID**: AMIP-99-FDB-01

3. **SPONSORING AGENCY**: WARSIM FDB Team, TRADOC

4. **ACCOMPLISHMENTS**: The S2ML program has completed initial research related to legacy systems' exercise data and an investigation into the extensible markup language. Collected source materials for use in data analysis. Populated Microsoft Access database tool with legacy system metadata from programs such as Janus, ModSAF, Corps Battle Simulation (CBS), JWARS, and JSIMS. Team has briefed concept and project at the SCC workshop, WARSIM PM meeting, and a JSIMS exercise data technical interchange meeting. In order to build the S2ML tool's language and program, Windows NT and SUN servers has been purchased. The data interchange format is the next item to be developed.

5. **LESSONS LEARNED:** Finding and receiving exercise data is never an easy task. Even with governmental approval, the contractor has had difficulty in convincing programs to release their data. Other programs, like JWARS, were glad to find someone working on this problem and offered their metadata to be used in the program. There are additional legacy and future systems that have not been included. Adding new exercise data from both types will further improve the standard, but the efforts need to be included in an FY00 proposal that encapsulates these data and makes a more universal standard. This has been proposed to the Data Standards Category for AMIP FY00 funding.

6. **BENEFITS TO ARMY**: With a single system to define the data interchange formats for simulation exercises, interoperability between future systems will be achievable and less costly. Reusing a scenario from one program to another would enable users to view how the models overlap and pave the way for HLA federation object model preparation and compatibility.

7. **WORK REMAINING TO BE COMPLETED**: This project is on schedule. Further work will involve the initial data interchange format description and lexicon for the S2ML (to be renamed the HLA Dynamic Scenario Builder). The standards document will need to be completed for proposal of a standardized Army exercise data interchange specification requirements and language.

8. **SCHEDULES WITH MILESTONES**:

Develop a draft logical data model	(June 99)
Design interchange mechanism/architecture	(July 99)
Specify requirements for supporting software	(Aug 99)
Document research activities	(Sep 99)

9. **POINT OF CONTACT**:

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FY99 AMIP and SIMTECH STEWARDSHIP REPORT

1. **PROJECT TITLE:** Risk Management Modeling

2. **PROJECT ID:** AMIP-99-FDB-02

3. **SPONSORING AGENCY:** US Army Safety Center

4. **ACCOMPLISHMENTS:** The Combat Soldering accident database was developed. A crosswalk was developed between missions and tasks of the Blueprint of the Battlefield (BoB) (TRADOC PAM 11-9, Apr 90) and those of its replacement, the Army Universal Task List (AUTL) (June 99 draft). Each of the nine accident databases (Day Rotary Wing, Night Rotary Wing, Wheeled Vehicle, Tracked Vehicle, Weapons Handling, Materiel Handling, Tactical Parachuting, and Combat Soldering) has been revised to reflect missions and tasks in the AUTL vice those in the BoB. Risk reduction controls have been developed for Combat Soldering accidents and Subject Matter Expert (SME) validation is in progress. Development of a prototype safety/risk management algorithm is in progress. Output of the Day and Night Rotary Wing accident databases and accident profiles have been used to develop prototype risk management modules. Each module consists of: a real-world mission scenario (with accident profile hazards built in); a doctrinally correct risk management "solution" for the scenario; and a 3-D, stealth view animation of the profiled accident (e.g., UH-60 whiteout, AH-64 wirestrike, etc.).

5. **LESSONS LEARNED:** Plan for significant delays from project approval until approval for the contractor to start work. The contractor started work on this project 3.5 months after the MIPR was approved due to delays in MIPR transmittal and Thanksgiving/ Christmas backlogs at the DSSW contracting office. Training audiences are accustomed to high fidelity, 3-D, stealth view animations seen on TV and movies and are disappointed with anything less.

   The prototype accident animations built with legacy simulators did not have the full visual impact and training value desired. Changes in Army doctrine will cause rework if the simulation product is to be current. The changes in missions and tasks from the BoB to the AUTL required development of a crosswalk between the two and extensive revisions to eight of the nine databases.

6. **BENEFITS TO ARMY:** Once posted, the databases will provide standard data for the nine most frequent types of accidents experienced in tactical training and real world operations. Presently awaiting posting instructions from FDB. The BoB-AUTL crosswalk provides doctrine, training, simulation, and lessons learned developers a tool permitting retention of the doctrinal relevancy of past work completed using the BoB structure of missions and tasks. The prototype risk management modules developed were used in two simulation exercises to train aviation brigade and battalion staffs immediately prior to their deployment to Bosnia. Modules will be developed for October training of a unit deploying to Kosovo.

7. **WORK REMAINING TO BE COMPLETED:** The goal is to successfully complete the project implementation plan by 14 Jan 00. The objectives and remaining accomplishments are to: complete the profiles analysis (delayed by AUTL compliance

work); post the nine accident data bases; complete controls development and validation; develop enhanced accident animations and use them in training exercises; and deliver final products.

8. **SCHEDULE WITH MILESTONES:**

WORK	MONTH 1*	2	3	4	5	6	7	8	9	10	11	12**
Accomplished												
Develop standard data base format	X	X										
Develop combat soldering database			X	X								
Develop BoB-Autl crosswalk and revise 8 databases					X	X						
Develop and validate combat soldering controls					X	X	X					
Develop and use risk mgt modules				X	X							
Planned												
Conduct profiles analysis (2)							X	X	X			
Post 9 databases							X	X				
Complete controls development and validation						X	X	X	X	X	X	X
Complete algorithm development					X	X	X	X				
Develop and use enhanced animations								X	X	X	X	X
Deliver final products												X

**** Feb 99 **Jan 00***

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FY99 AMIP and SIMTECH STEWARDSHIP REPORT

1. **PROJECT TITLE**: Development of Aggregation Standards for On-Road/Off-Road Logistical Movement in Theater Level Warfare Simulations

2. **PROJECT ID**: AMIP-99-MOVE-02

3. **SPONSORING AGENCY**: US Army Engineer Research and Development Center, US Army Corps of Engineers

4. **ACCOMPLISHMENTS**: The project objective involved developing a standard methodology for aggregating logistical networks and retaining throughput or capacity characteristics. To date, procedures for aggregating networks, characterizing aggregated capacity associated with arcs/links, and for deriving capacity or pass rate standards have been developed. After comparing various methods, a modified classical thinning algorithm was implemented with a gridding system to aggregate the transportation networks. The algorithm begins with first rasterizing transportation vectors before thinning the data and converting it back to a vector (Arc/Node) network. The density of grid cells used will determine the complexity of the resulting aggregated network (i.e. a 200x200 matrix will produce a simpler network than a 400x400 matrix). Obviously, the fewer grids used to parse the network, the closer the abstraction is to the original network. Investigations related to "how much to aggregate" are ongoing. To address the issue of retaining the capacity/throughput of the original arcs for the aggregated arc, a sampling method was employed. Cross-sections perpendicular to the newly created arcs are used to sample the initial transportation network to develop a description of the arcs that comprise the simplified network. These cross sections relate each arc to a corresponding throughput for the aggregated arc. Furthermore, standards were developed for estimating the capacity associated with an arc. This methodology was based on the NATO Reference Mobility Model (NRMM) and derivative Convoy Movement Model. NRMM is the recommended standard for ground vehicle movement. Road profiles were generated for categories of road type, topology, and visibility conditions and convoys were "driven" over the profiles to determine traverse times and pass rates. The proposed categorization provides a spin-off standard from the work capacity estimation. Software has been developed to generate the movement network for JWARS.

5. **LESSONS LEARNED:** No standards existed for capacity, or pass rate, estimation. Readily available factors (road type, topology, e.g.) are good determinants that can be used to categorize capacity distributions.

6. **BENEFITS TO ARMY**: Theater level logistical movement planning and simulation will be more effective and consistent in capability to plan logistical movement in each theater of operations.

7. **WORK REMAINING TO BE COMPLETED**: Complete algorithm development based on measures of performance, conduct comparison regarding effects of aggregation, provide guidelines on gauging aggregation limits, and document description of standard.

8. **SCHEDULES WITH MILESTONES**:

Completed analysis of methods to aggregate logistical networks	2Q99
Completed investigation of the interaction of logistical units with varying levels of road/off-road network aggregation	3Q99
Recommend a standard for the representation of logistical networks within theater-level simulations (Est)	4Q99

9. **POINT OF CONTACT**:

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FY99 AMIP and SIMTECH STEWARDSHIP REPORT

1. **PROJECT TITLE**: The Influence of Vehicle Geometry on Maneuverability within the NATO Reference Mobility Model

2. **PROJECT ID**: AMIP-99-MOVE-03

3. **SPONSORING AGENCY**: National Ground Intelligence Center, NGIC
   Army Materiel Systems Analysis Activity, AMSAA
   US Army Engineer Research and Development Center, (ERDC), USACE

4. **ACCOMPLISHMENTS**: NGIC has promoted NRMM and the upgrading of NRMM to several customer groups. TRADOC, CASCOM, and Transportation School, Ft Eustis have been made aware of model and upgrades at several meetings. Model acceptance has improved. Heavy Equipment Transporter Program Managers Office has benefited directly from these changes. Current possible redirection may reduce the overall impact, but new staff education is currently ongoing. TACOM-TARDEC model research group has been contacted with resulting increased model interest. Greater change and coordinated use of the model are projected.

   NGIC, AMSAA, and WES have all jointly contacted Germany NRMM users. Research, planned visits and perhaps greater joint use of the model have been discussed.

   AMSAA'S portion of the AMIP project is to implement into NRMM, verify, and validate a new maneuver methodology that considers the geometry of the relationship between obstacles and the length, width, and articulation ability of the vehicle. The new maneuver methodology will supplement the empirical approach to maneuver currently used by NRMM.

   So far the new computer code based on the new maneuver methodology has been written and installed into NRMM, the code has been documented, and user instructions have been written. Scale drawings of all the interference cases considered by the new maneuver methodology have been created as verification that the computer code works properly. Results comparing the old and new code have been made and validation tests have been developed.

   WES has conducted two additional HET field tests in sand. These are for other projects but also produced additional sand strength and vehicle sinkage data. WES investigated the existing algorithms to predict vehicle sinkage for both coarse-grained and fine-grained soils. The fine-grained algorithms seem to be in relatively good shape. For coarse-grained soils, the WES numeric algorithms will probably be used. Little suitable information was available from the existing test results of the HET test program conducted by WES a few years ago. It turned out that most of the testing was done on a layered sand surface. The top layer had insufficient strength to support the vehicle while the lower layer was sufficient. The results show that the vehicle sank through the top layer to the second, a result which should have been predictable. If the surface layer was of sufficient depth, then it caused trafficability problems. Because in this test study the strength of the lower, harder soil was not quantified, it was not possible to determine an average soil strength and make nessary comparisons with the WES numeric model.

5. **LESSONS LEARNED:** NGIC, AMSAA, and WES have found greater coordination is required to alert other users of the planned changes and that customers do not fully understand some of the NRMM capabilities. A more user friendly version of NRMM may be needed. Basic marketing information for the NRMM needs to be developed.

   AMSAA has moved quickly through the methodology and computer code portions, however coordination and scheduling of validation tests has added time and complications.

   NGIC and WES have found that data developed during tests for other customers is not as useful as originally estimated.

   WES data transfer methods between field test elements and software developers needs greater coordination and more systematic planning.

6. **BENEFITS TO ARMY:**

   NRMM improvement will positively impact acquisition, large scale force modeling, and research.

   NGIC has been involved in use of NRMM output data as part of new vehicle procurement by TRADOC and TACOM during this model improvement project. The changes and generally increased use of NRMM have improved the impact of this involvment.

   This AMIP project could spark a general NRMM modernization.

7. **WORK REMAINING TO BE COMPLETED:**

   NGIC, AMSAA, and WES plan to increase model awareness and use through planned meetings with Germany and TACOM. Final work also includes contact with UK and France representitives.

   AMSAA has a validation effort that is being coordinated with NGIC and WES and the validation tests will be performed in August 99. The code may be modified depending upon the results of the validation tests. A Final Report will be written by the end of September 99.

   WES is scheduled to run additional HET tests this fall which should provide some more meaningful results. After this, possible ‘fine-tuning’ the numeric scheme and finalizing the sinkage algorithms will be completed. Then the actual computer codes for inclusion into the NRMM will be finalized..

8. SCHEDULES WITH MILESTONES:

NGIC:	**% Complete**
Manage, promote and coordinate	60
Contact US Customers	50
Contact Foreign Users	40

AMSAA:

Efforts	**% Complete**	**Schedule Milestones**
Phase 1.		
-Writing and installation of computer code	100%	Mar 99
-code documentation	100%	Apr 99
-user instructions	100%	Apr 99
Phase 2.		
-Scale drawings of each kind of interference case	100%	May 99
Phase 3.		
-Comparison of old code/new code results	75%	Jun 99
-Development of validation tests	75%	Jun 99
-Coordinate validation effort	0%	Aug 99
-Complete V & V documentation	50%	Aug 99
-Final Report	0%	Sept 99

ERDC:	**% Complete**
Acquire Field Test Data	80
Modify Model Algorithms	20
Validate Model Changes	10

9. POINT OF CONTACT:

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FY99 AMIP and SIMTECH STEWARDSHIP REPORT

1. **PROJECT TITLE:** Standard Object Development

2. **PROJECT ID:** AMIP-99-OBJ-01

3. **SPONSORING AGENCY:** US Army Materiel Systems Analysis Activity (AMSAA)

4. **ACCOMPLISHMENTS:** The OMSC conducted a revision of the Platform Object and Unit Object based on the development of a use case. Additionally, the OMSC discussed, modified, and documented the Location Object and the Data Collection Object Structure. The Environment Object, comprised of a Terrain Object, Atmosphere Object, Space Object, and Ocean Object, was developed as a draft and coordinated with the Terrain Standard Category. Also developed and refined was the Behavior Object that defines behaviors associated with the Platform and Unit Objects. The following is a synopsis of the OMSC's FY99 accomplishments:

   - <u>Platform Object Updates</u>. Based on the continual review of the Platform Object and the development of a Platform Object use case, the Platform Object was updated in the following manner:

     - The "aim" and "fire" methods listed in the Weapon Object were consolidated into the "engage_target" method as the former are internal actions that do not have to be shared with other objects.
     - The "get_Size" method in the Platform_Frame and Platform_Frame_Component was changed to "get_Signature" to more accurately describe its ability to represent multiple signature types.
     - The OMSC website Platform Object section was updated with these changes.

   - <u>Unit Object</u>. Based on the continual review of the Unit Object, the Unit Object was updated in the following manner:

     - The "speed" and "direction" methods in Unit Object were consolidated in a "velocity" method.
     - The "look" method in the Intel Object was changed to "collect".
     - The OMSC website Unit Object section was updated with these changes.

   - <u>Location Object</u>. This object consists of the Local Object and the LatLon Object. The notion of location is fundamental to most military simulations. There are numerous coordinate systems used in simulation, each appropriate for some simulations and not suitable for others. A common, abstract location object can foster interoperability among simulations that use different coordinate schemes. A draft object was presented at the May workshop and updated based on participant's comments. Three options for the Location Object were posted on the OMSC reflector with additional comments provided. The Location Report was re-drafted based on the community comments and will be posted again for review in Aug 99. It is anticipated that a Senior Reviewer vote will take place prior to the close of FY99.

- Data Collection Object: This object allows the M&S user to adopt data services that can be tailored to address unique study analysis data requirements. A report was drafted to define the object structure, methods, definitions, and use case. A draft object was presented at the May workshop and updated based on participant's comments. The Data Collection Object Report was drafted based on the community comments and will be posted on the OMSC reflector for review by Aug 99. It is anticipated that a Senior Reviewer vote will take place prior to the close of FY99. A draft Data Collection Object structure, definition, and report were posted on the OMSC website.

- Environmental Object. An Environment Object was defined to represent the physical reality used in simulations. The Environment Object is comprised of a Terrain Object, Atmosphere Object, Water Object, and Space Object. The OMSC initiated development of the Environmental Object and the object methods that are considered the minimum essential to represent terrain. A number of COMBAT XXI developed Environment Object methods, especially with respect to the Water Object, were adopted. While the Environment Object structure and definitions were agreed to by the OMSC at the May Workshop, comments from coordination with the Terrain SC via their reflector provided a number of comments that questioned the Terrain Object design in particular and the OMSC standard object approach in general. Further interaction and coordination with the Terrain SC are required before the Environmental Object can move further through the approval process. It is anticipated that the first quarter of FY00 will involve discussions on the final form of the Environment Object.

- Behavior Object. Sophisticated modeling of combat requires simulations to provide model entities with the capability to react to induced stimuli when they occurs. The OMSC developed a Behavior Object that defined the behavior actions necessary for simulations to model combat entities. This object includes the classification and integration of combat behaviors, from individual soldiers up to command level, into Army standard objects. A first draft report was written and discussed at the May Workshop. This draft was posted on the OMSC website. Comments, to include the development of a planning object, are being incorporated in a second draft to be submitted for review at the beginning of FY00.

- JCDB/OMSC Interaction: At AMSO's request, the OMSC and C4I Integration SC met to discuss whether alignment of the OMSC standard objects and Joint Common DataBase (JCDB) data model would benefit simulation integration. The two parties met at a May Workshop joint session and again in July to discuss the issue. After exchange of briefings and discussion of integration issues, the two groups agreed to hold a three-day meeting to go over the specifics of the OMSC object standards and the JCDB (soon to evolve into the Army Integrated Core Data Model (AICDM)). The purpose of this meeting is to further understand the content of the two approaches and identify ways, if any, in which the data model and object standard approaches can integrate to support M&S interoperability. The minutes of the 13 July meeting were posted on the OMSC reflector.

5. **LESSONS LEARNED:** Activities this year reinforced the notion that close and effective cross communications between the different Standard Categories are required to improve M&S standards development. On several occasions, questions were raised concerning OMSC objects being developed. In some cases, the subject matter experts voicing their concerns provided additional insights into a modeling area. These insights improved the object design under consideration. In other cases, the perceived conflict could be attributed to differences in the level of detail or focus being pursued by both groups. The OMSC is directing its efforts at developing abstract or high level design templates that cross model domains; subject matter experts voicing their concerns typically focus on a specific modeling domain or have developed highly detailed approaches to a specific modeling area. Once OMSC objectives are explained, the objections are typically withdrawn. In either case, the cross communications are beneficial to all involved.

6. **BENEFITS TO THE ARMY:** This project supports Army efforts to pursue model and simulation interoperability and reuse. The ultimate benefits to be derived from the availability of standard Army objects include:

- reduced knowledge engineering development efforts for new models
- enhanced interoperability/interactivity
- reduction in duplication of effort, and
- identification of investment opportunities to address modeling and simulation voids.

7. **WORK REMAINING TO BE COMPLETED:**

- Final coordination and publication of Location Object Report
- Final coordination and publication of Data Collection Object Report
- Coordination and update of the draft Environment Object Report
- Review, coordination, and initial draft of the Behavior Object Report

8. **SCHEDULES WITH MILESTONES:**

· Refinement of Location Object Structure/Definitions	Nov 98
· Refinement of Data Collection Structure/Definitions	Nov 98
· Development of Behavior Object Structure/Definitions	Dec 98
· Coordination of Location Object Structure/Definitions	Jan 99
· Coordination of Data Collection Structure/Definitions	Feb 99
· Coordination of Behavior Object Structure/Definitions	Feb 99
· Development of Environment Object Structure/Definition	Apr 99
· Draft Report of Behavior Object Structure/Definitions	May 99
· Coordination of Environment Object Structure/Definitions	June 99
· Draft Report of Location Object Structure/Definitions	July 99
· Draft Report of Data Collection Structure/Definitions	July 99
· Draft Report of Environment Object Structure/Definitions	July 99
· Crosswalk of JCDB with Platform/Unit Objects/Meet w/ JCDB	July 99
· Final Coordination of Location Object Structure/Definitions	Aug 99

- Final Coordination of Data Collection Structure/Definitions Aug 99
- Coordination with Terrain SC of Environment Object Sep 99
- Senior Reviewer Vote on Location Object Sep 99
- Senior Reviewer Vote on Data Object Sep 99

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FY99 AMIP and SIMTECH STEWARDSHIP REPORT

1. **PROJECT TITLE:** The Composable Behavior Standard Data Acquisition Project

2. **PROJECT ID:** AMIP-99-SAF-01

3. **SPONSORING AGENCY:** Headquarters, US Army TRADOC Analysis Center (TRAC) *and* Headquarters, US Army National Simulation Center (NSC) MACOM: Headquarters, US Army Training and Doctrine Command (TRADOC) Deputy Chief of Staff for Simulations, Studies, and Analysis, Attn: ATAN, TRADOC Project Officer OneSAF

4. **ACCOMPLISHMENTS:** This two part project was developed to set human behavior composability standards for future Army simulations by developing a library of the fundamental actions (primitive actions) required to simulate human and system actions in combat at the entity level and using these basic actions in use case methodology developed by the NSC for presentation of behaviors. This collaborative effort of TRAC and NSC was modified to accommodate the loss of the NSC concept originator. The NSC will now provide behavioral definitions and primitive actions for support of civilian play in M&S generated by research for special operations forces modeling.

   The combat primitive library has been initialized. Generic primitive actions used in the CASTFOREM M&S have been identified and entered into the library. The purpose of each primitive has been defined along with possible parameter types normally associated with it. The range of primitives include all Army functional areas. This initial library will serve as a baseline for validation.

   Researching the concept of primitive actions has exposed a requirement to refine the definition of primitives. The term primitive must be relative to the M&S fidelity. As a result, this project has been expanded to classify primitives by the fidelity of the M&S they support. The library developed for ASTARS will designed to accommodate these different type of primitives. The proposed classification labels are engineering, entity, and aggregate. The primary thrust of the project remains at the entity level.

   The NSC piece is less mature. The NSC was only introduced to the concept of primitives in October, but the NSC's project lead felt that the research work supporting SOF would be important to future TEMO M&S and wanted take the opportunity to initiate a primitive library for civilian and SOF behaviors. The NSC is in the process of defining these civilian and SOF behaviors.

5. **LESSONS LEARNED:** After explanation, the concept of primitive actions is relatively intuitive to most M&S community members; however, the understanding of the concept by each person is relative to their modeling experience. The result is a variety of ideas as to what each primitive will do. To illustrate this problem, multiple primitive actions defining actions by a tank crew doing the crew drill to fire the main gun could be subsumed by one aggregate primitive for the tank (i.e., fire). The original intent of the project was to develop a primitive library which captured system versus individual (e.g., tank versus tank crew)

actions; a level that would be expected at ModSAF/CASTFOREM level. However, the argument has been posited that OneSAF must be able to support all domains as well as functional areas. This realization has obviated the requirement to develop primitives at multiple levels of fidelity. To capture all of these levels is beyond the scope of the project resources; however, the structure for the primitive library to be reposed in the ASTARS will be designed accommodate these levels for future populating.

6. **BENEFITS TO ARMY:** The concept of primitives is to support Army M&S user composability of behaviors (tactics, C^2, situation perception, course of action development, etc). The ability of the user to develop behaviors on site that meet user application requirements provides significant efficiency improvements to rapid turn around times, validity and precision, and cost savings. Primitives are part of an M&S composability functionality tool set. In the text form which they will be reposed in ASTARS, they are generic. This means they can be developed into functioning software code using the most current or variable fidelity physical models and algorithms, whatever the M&S development requires. Therefore, the ASTARS reposed primitives are reusable by definition and will support all future M&S developments. In addition to the improved efficiencies cited above for composability, the effort to capture primitives will prove an improved efficiency by providing non-military software developers with prepared operational concept "packages." The developer will not have to waste time trying understand and then develop a concept for primitives and composability; he/she can move into selecting physical models and algorithms to develop these concept packages into functioning code.

7. **WORK REMAINING TO BE COMPLETED:** The domains and the combat developments division (DCD) at each of the functional area schools will be asked to validate the primitive lists for their functional area. In the process of validating, each domain and DCD will be asked to identify additional primitive actions and parameter types unique to each of the functional areas.

   The NSC must complete its process of defining civilian and SOF behaviors. The results of their research will be used to derive a primitive library. It is expected that SOF experts will validate the NSC's primitive library.

8. **SCHEDULES WITH MILESTONES: None**

9. **POINT OF CONTACT**:

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FY99 AMIP and SIMTECH STEWARDSHIP REPORT

1. **PROJECT TITLE:** Modular Terrain for Entity Level Computer Generated Forces (ModTerrain)

2. **PROJECT ID:** AMIP-99-SAF-02

3. **SPONSORING AGENCY:** Headquarters, US Army TRADOC Analysis Center (TRAC) *and* Headquarters, US Army Training and Doctrine Command (TRADOC) Deputy Chief of Staff for
Simulations, Studies, and Analysis, Attn: ATAN, TRADOC Project Officer OneSAF

4. **ACCOMPLISHMENTS:** This project designed a terrain interface and prototyped a modular run-time terrain component that hides the details of the terrain representation from an entity level CGF system. This component contains a standard set of terrain services that allow the application to use the terrain database independent of the underlying terrain representation. By using such routines, legacy simulations and emerging CGF systems can use different terrain formats at run-time without source code changes. The run-time terrain representation can also be changed internally without impacting systems that already use existing standard terrain services. Simulation or terrain module developers can extend the standard interface to provide those services not anticipated or not currently required by most CGF systems.

   To date this research has produced: (1) a draft functional description and white paper which server as the draft standard for the ModTerrain run-time terrain API specification; (2) a C++ prototype (using ModSAF CTDB) run-time terrain module using the draft standard; (3) a Java prototype (generic terrain) run-time terrain module using the draft standard; (4) a conference paper describing the ModTerrain project; and (5) a masters thesis by an NPS student describing the Java prototype.

5. **LESSONS LEARNED:** Community review and early prototyping have contributed significantly to the quality of the standards nomination and supporting documentation. It is important to coordinate with related standards initiatives to leverage (where possible) existing or future standards.

6. **BENEFITS TO ARMY:** This research supports composability and interoperability in legacy and future M&S applications, such as OneSAF and COMBAT XXI, by providing a modular and extensible standard application programmer's interface (API) specification for terrain modules in entity level computer generated force (CGF) simulations.

7. **WORK REMAINING TO BE COMPLETED:** During the remainder of FY99, the research team will (1) complete the standards nomination for the run-time terrain module API specification; (2) complete the ModTerrain experiment; and (3) write an interim technical report. In FY00 the research team will (4) conduct a proof of

principle demonstration (POP-D); and (5) write a final technical report. They will deliver the interim report in September 1999, and the final technical report in June 2000.

8. **SCHEDULES WITH MILESTONES:** The project consists of three phases each culminating with a written product.

Phase I. Preliminary API Definition (March 1999). In Phase I, the research team proposed a standard API definition and develop a detailed implementation methodology. Phase I culminated with the distribution of a draft API standard to the SAF, Terrain and Object Management SCCs. The draft API standard includes both a functional description and white paper.

Phase II. Prototype Development & Experimentation (September 1999). In Phase II, the team implemented two prototype terrain modules using the draft standard and they are now conducting a series of experiments to benchmark performance characteristics of the C++/CTDB prototype. The research team will write an interim technical report to detail the API specification, to describe and document the prototype implementation, and to document the experimental results of the prototype testing. Phase II culminates with distribution of the interim technical report.

Phase III. Demonstration, Testing & Documentation (June 2000). In Phase III, the team will implement the API for an entity level simulation's native terrain representation using the draft standard. They will modify/code the entity level simulation so that terrain service calls also conform to the draft standard. They will then integrate the prototype terrain module of Phase II into the entity level simulation and demonstrate composability and improved interoperability. The demonstration (POP-D) will prove that an entity level simulation can use two different run-time terrain representations through the standard API. Phase III culminates with distribution of a final technical report documenting project results.

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FY99 AMIP and SIMTECH STEWARDSHIP REPORT

SIMTECH FUNDED PROJECTS

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FY99 AMIP and SIMTECH STEWARDSHIP REPORT

1. **PROJECT TITLE**: Automated Universal Data Collection and Analysis (ADCAT)

2. **PROJECT ID**: SIM-99-AMC-01

3. **SPONSORING AGENCY**: AMCOM

4. **ACCOMPLISHMENTS**: To date the project has completed the prototype development of the Database Schema Generator and the Data Subscription Module.

5. **LESSONS LEARNED:** Lessons Learned during the design, development, and implementation of the Database Schema Generator and the Data Subscription Module include the following:

   Data subscription in FOMs with many layers of inherited classes is problematic for novice users. To accurately subscribe to all data members of a child class, the tool must generate appropriate subscriptions to the parent and child class data members.

   Generation of a fast and efficient query mechanism in the generated database is problematic given the wide range of FOMs evident in the HLA community. To generate a robust query logic would require extensive code development and modification for each schema. The solution developed was to leverage natural language query support from within a graphic user interface.
   Combination of MOE elements is improved through the use of set theory constructs such as union, difference, and intersection. This technique seems to be intuitive to a wide range of users.

6. **BENEFITS TO ARMY**: The end product will provide the capability to use the data collection tool with any Federation Object Model (FOM) and set of Measures of Effectiveness (MOE) desired without recoding the user interface, data subscription methodology, or database. The tool will allow a user to traverse the native FOM to select the base data elements required for analysis. These elements will then be automatically subscribed to via the Run Time Interface (RTI) and then populate a database in their native FOM forms. The data elements will then be recombined to form MOE, which are then graphed for the user interactively. This approach will allow even novice users to leverage HLA experiments for robust data collection and analysis in a fully automated and portable manner.

7. **WORK REMAINING TO BE COMPLETED**: The project must finalize the development of the prototype components and develop the Dynamic Graphic User Interface component. Finally, all components must be integrated and tested.

8. **SCHEDULES WITH MILESTONES**:

09 AUG 1999	Prototype of Database Schema Generator
23 JUL 1999	Prototype of Data Subscription Module
01 OCT 1999	Completion of Database Schema Generator
01 OCT 1999	Completion of Data Subscription Module
01 OCT 1999	Completion of Dynamically Customized GUI
15 OCT 1999	Integration Complete
03 DEC 1999	Completion of Testing
24 DEC 1999	Delivery of Executable Software

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FY99 AMIP and SIMTECH STEWARDSHIP REPORT

1. **PROJECT TITLE**: Simulation Support Environments (SSE) for Army Modeling and Simulation (M&S) (SSEAMS)

2. **PROJECT ID**: SIM-99-AMC-02

3. **SPONSORING AGENCY**: Army Materiel Systems Analysis Activity, Army Materiel Command

4. **ACCOMPLISHMENTS**: AMSAA evaluated the Joint Modeling and Simulation System (JMASS) as a simulation support environment (SSE) for Army M&S activity. To support this evaluation, we used JMASS to build and exercise a JMASS compliant version of the Incursion model. Incursion, an Army standard model, is a one-on-one Air Defense engagement model, used to represent Air Defense Effectiveness in force level simulations such as VIC and Eagle.

   The Implementation Plan submitted in August of 96 contained a list of projected milestones. Completion dates are listed in Section 7.

   Technical Report No. TR-643 provides an overview of the lessons learned and insights gained through a JMASS evaluation and the related activities. It describes what a SSE is (or should be), how it relates to the High Level Architecture (HLA), and how both the JMASS and HLA programs can help in achieving greater reuse. The report includes five appendixes that contain more detailed information about AMSAA's pilot project, algorithm verification, object oriented design of the Incursion simulation, JMASS software structural models, and JMASS model development.

5. **LESSONS LEARNED:** None

6. **BENEFITS TO ARMY**: Simulation based acquisition (SBA) is one manifestation of a continuing call for greater use of M&S throughout the DoD. The intent is to facilitate integration of M&S tools and technology across acquisition functions, program phases, and programs. The Army's implementation is Simulation and Modeling for Acquisition, Requirements, and Training (SMART). The intent is to facilitate integrated product and process development during all phases of the weapon system lifecycle. This process will require extensive reuse of M&S among many organizations within the Army and throughout the DoD. HLA and JMASS are two complimentary programs intended to help achieve this level of reuse. HLA enables reuse at the simulation level, where entire simulations are the software models to be reused. JMASS is aimed at establishing a SSE as a tri-service standard.

   Through this project, we supported DA participants to ensure that the JMASS standard will meet Army M&S needs. In addition, we produced an updated version of Incursion which is more flexible to use, easier to modify and maintain, and has, through JMASS, the potential for further improvements, such as few-on-few capabilities and HLA compliance. This project facilitates the concept of M&S reuse.

7. **WORK REMAINING TO BE COMPLETED**: None

8. **SCHEDULE WITH MILESTONES**:

Milestones	Actual
Completed C++ training	Nov 96
Established a JMASS site	Feb 97
Completed JMASS training	Apr 97
Completed JMASS Incursion	Dec 97
Results and Observations	May 98
Published Technical Report	Mar 99

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FY99 AMIP and SIMTECH STEWARDSHIP REPORT

1. **PROJECT TITLE**: Comparative Simulation State & Path Research/Interpretation

2. **PROJECT ID**: SIM-99-CAA-01

3. **SPONSORING AGENCY**: Center for Army Analysis (CAA)

4. **ACCOMPLISHMENTS**: Though funded at only one third the requested, modest amounts, Drs. Gilmer and Robinson made significant discoveries and progress. Two-way exchanges with CAA's internal research on hierarchical modeling (particularly via ATCAL linking) have been mutually beneficial. Recall that the project within and outside CAA is tackling a variety of disturbing (to those who really care) real and suspected phenomena and artifacts uncovered in decades of modeling experience: non-monotonicity and chaos, non-scalability of MOE, $E(f(x)) \neq f(E(x))$, aggregation/ disaggregation failures, composition/decomposition discrepancies, 1-on-1 to m-on-n data and modeling inconsistencies, unitary vs hierarchical modeling systems, and a variety of strange results under input perturbation. The research attempts to reconcile as many as possible of the foregoing via some heavy duty abstraction and mathematics.

   a. A hypothesis of Dr. Gilmer's [Gilmer99] research is that explicit control over the resolution of random events, rather than chance, can allow more to be learned about the outcome space of a simulation and scenario, especially in producing the largest possible number of dimensions in the outcome space. Earlier work with simpler scenarios had shown that the multitrajectory technique produced superior results in matching an MOE probability density plot of LER vs Blue Losses for at least some scenarios. However there were unexplained discrepancies, for example, the multitrajectory MOE plots were consistently grainier than the stochastic plots. A considerable effort has been made to understand and explain (or fix) those discrepancies, including debugging, event analysis, and theoretical development. But to this time, the full explanation has remained elusive. Progress has been made toward a less rigid software control structure that would allow "depth first" ond other strategies for exploration of the tree of possible simulation trajectories. Current methods require time to be consistent in all states, resulting in severe memory constrained limits. Event analysis methods have also been developed, that will be used to dynamically evaluate event importance, and guide the choice of trajectories to maximize the variety of outcomes.

   b. An unexpected insight has emerged about the behavior of combat simulations. Initial work with limited numbers of units and events showed nonmonotonic behavior in the outcome space, as projected onto a surface plotting LER vs Blue Losses. But the larger scenarios of this study, ranging from 40 to 640 units, have shown consistently well behaved, smooth, almost Gaussian surfaces. Indeed, the smoothness may be a factor in why, for these scenarios, the multitrajectory technique has not shown more advantage. If the event type that has been seen to have the greatest importance, decisionmaking, is resolved deterministically instead of stochastically, then nonmonotonicity appears, although locally the surface still seems to be fairly smooth. This seemingly “good” behavior on the part of a simulation with plenty of nonlinearity and thresholds is surprising, considering all of the attention given to “chaos” in combat simulations recently. It would be interesting to explore a greater variety of scenario types and features to see how robust this behavior is.

c. Dr. Robinson [Robinson99]is considering the extent to which the formalisms of dual spaces, dual variables, marginal values and the like may be applicable to sound, dynamic weapon evaluation and choices among alternative courses of action in the short tactical to long strategic runs. Can the a priori skullduggery of much target prioritization and scripting be replaced by in-line situational measurement and assessment? ATCAL is one of few known cases in which weapon evaluation is dynamic. Dr. Robinson made a case study of ATCAL. He undertook to identify places in the ATCAL code where either the performance of the method was unclear, or else the code did not correspond to the description of the method in [TP83]. The effort resulted in identification of several apparent discrepancies and questionable portions of code, descriptions of which were forwarded to CAA for their consideration. Also, during this process an extensively commented set of code for ATCAL Phases I and II was produced, which has also been supplied to CAA. There has been a continuing effort to improve computational methods that can be used to compute importances in ways that may be more robust and effective than the method used in [TP83]. Attention was given to the following areas:

1. Improvement of the MATLAB homotopy code to deal with peculiarities of the Nash equilibrium structure characteristic of importance calculation (for example, different path orientations and singular solutions).
2. Determination of a regularization scheme that removes objectionable instability without causing too much alteration of the underlying values.
3. Identification of a preferred class of shadow-pricing models, among those described above, for importance calculation in ATCAL.
4. Computational comparison of values produced by this procedure with those computed using the present ATCAL methodology.
5. Preliminary documentation of the methodology and results.

d. Dr. Robinson made progress on these, primarily through use of the homotopy continuation code for solving variational inequalities, whose MATLAB version was prepared under the FY 98 work program of this project. Most of the accomplishment in the current period has been in improving stability and adapting the code to run with various importance models. Additional related work has been done with ARO funding under the general program of the grant of which the SIMTECH project is a part.

During FY99, CAA analysts studied the engagement decomposition and recomposition properties of ATCAL, discovered a non-scalability property of current weapon importances [TP83], proposed an alternative importance family, and noted a gap between 1-on-1 and m-on-n reasoning in several data to model, model to model, and intra-model derivations and applications. CAA analysts speculated that development of a path algebra and path calculus is desirable and, though difficult, lies within reach. Expository papers helped clarify the relation of path bases to modeling and model calibration. TP83 is being updated and annotated.

5. **LESSONS LEARNED:** Although the project involves much deep theory, the work is very much driven by case studies. Gilmer has studied millions of paths. CAA has provided Robinson with material bases on thousands of ATCAL runs. All have looked at other sources and models, though less deeply. They have found very little that rests on what can pass as a solid theoretical or empirical foundation. Very big models are being built with poor root systems. The Gilmer's and Robinson's worry about the roots and can grow some even when only modestly supported. Yet the military modeling world often shouts, "Damn the roots, full speed ahead."

6. **BENEFITS TO ARMY**: In the short run (within a year), dynamic treatment of weapon importances can be put on a much sounder footing; the method can be implemented and tested at full theater campaign analytic level. In the long run (still several years hence), the determination of necessary and sufficient path sets can put more modeling and simulation on sounder bases.

7. **WORK REMAINING TO BE COMPLETED**: Although several significant discoveries have been made, exploitation of those and much more research remain to be done. Gilmer does not yet have a real explanation for the differences between deterministic and stochastic multipath behavior at different scales. He does not yet know how to construct necessary and sufficient path bases. Dr. Robinson has not yet tied Cooper's heuristic weapon importance to any formal and theoretically sound foundation. Cooper has reduced some model firing and hits discrepancies ten-fold but has not tested the "fix" over the full domains of interest. Path algebra and path calculus are in their infancy.

8. **SCHEDULES WITH MILESTONES**: Neither Gilmer nor Robinson pursues this research as his principal source of livelihood. If funding of this project can be continued and grad students assigned, (a) Dr. Gilmer must do testing and cleanup of the sofware tools needed for the research. He cannot yet say with certainty that smoothness (or graininess) is not bug-driven. The exploration of trajectory or path space still requires millions of cases. The (hoped for) smaller set that spans a path space in support of a modeling hierarchy remains unknown at this date. (b) Dr. Robinson expects to continue work on weapon importances, especially in the relation of dual (shadow-pricing) methods to extensions of the linear and affine models described in [Cooper 99b-99d]. Robinson seeks also to develop some dual-theoretic means to assist in the generation of Gilmer's necessary and sufficient path sets.

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FY99 AMIP and SIMTECH STEWARDSHIP REPORT

1. **PROJECT TITLE**: Enhancement to Theater Air Defense Analysis Cluster

2. **PROJECT ID**: SIM-99-CAA-02

3. **SPONSORING AGENCY**: Center for Army Analysis (CAA)

4. **ACCOMPLISHMENTS**: As planned, Silicon Graphics Octane and visual workstations configured to run EADSIM and thereby greatly enhance CAA's ability to conduct theater air defense analyses were ordered, received, installed, and tested and are now fully integrated within CAA's Air Defense Analysis Cluster.

5. **LESSONS LEARNED:** Apart from a few unwelcome delivery delays (vendor first delivered to wrong agency!), a typical Government acquisition cycle. Hence, usual lesson: be persistent and patient.

6. **BENEFITS TO ARMY**: Project more than doubled CAA's EADSIM-based capabilities to prepare, execute, conduct analyses, record, document and display results of theater air defense scenarios (especially theater missile defense) as parts of theater campaign analyses.

7. **WORK REMAINING TO BE COMPLETED**: None.

8. **SCHEDULES WITH MILESTONES**: SGI accepted order 29 April 1999. Installed and tested workstations functional at CAA in July 1999.

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FY99 AMIP and SIMTECH STEWARDSHIP REPORT

1. **PROJECT TITLE**: Composeable Behavior Technology Implementation

2. **PROJECT ID**: SIM-99-ODCSINT-01

3. **SPONSORING AGENCY**: ODCSINT

4. **ACCOMPLISHMENTS**: This project applies the "Composable Behavioral Technology" developed by SAIC under contract to STIRICOM to object-oriented behaviors delineated in the National Ground Intelligence Center's Conceptual Model Repository. The goal is to develop the technology to identify and combine primitive behaviors using a standard set of conditions and predicates in order to represent the full array of foreign ground force tactics, techniques and procedures. This will permit doctrinally correct foreign behaviors to be used in combat models with a minimum of controllers.

   The previous Composeable Behavioral Technologies (CBT) project focused on creating a graphical user interface (GUI) which allowed an end-user to easily compose behaviors from a set of pre-defined primitive and predicate behaviors. The GUIs developed during the initial phase gave the user a simplified means of creating, storing, and executing complex behaviors. Therefore, the initial idea of a behavior repository, use of a logic-diagram for behavior creation, and the main architecture of the system was developed during that project.

   This effort began with a task analysis in order to select and scope a suitable behavioral domain and determine and define the refinements necessary to include temporal relations, reactive behavior processing, and improved command and control behavior processing. National Ground Intelligence Center (NGIC) and TRADOC Analysis Center (TRAC) subject matter experts (SME), under the guidance of SAIC, identified foreign fire support behaviors for two sets of countries. The development of primitive and predicate behaviors for two country sets will accomplish two goals: 1) ensuring that the CBT is sufficiently robust to accommodate multiple behavioral representations, and 2) demonstrating that the technology is sufficient to capture and demonstrate differences in behaviors.

   NGIC and TRAC SMEs created a scenario to scope the effort and bound the set of primitive and predicate behaviors. This activity included identifying the entities to be modeled and describing their behaviors. These behaviors were decomposed by STRICOM/SAIC, with the help of the SME to create the initial primitive and predicate behaviors. Work is ongoing to complete the behavior set, capture them in the behavior repository and ensure completeness.

5. **LESSONS LEARNED**: The existing CBT tool set and graphical user interface appear to be adequate to handle the foreign behaviors, with one exception identified to date. Because some foreign fire support activities require multiple message types, the capability to model communications networks would be useful. The existing Unit

Editor could be modified to permit this but may not be accomplished during this project.

The object-oriented (OO) behavior descriptions produced by NGIC as input to this effort have proved to be useful as general descriptions but in some cases lack sufficient detail to permit direct identification of primitive behaviors. A comparison of the final set of primitive and predicate behaviors with the OO descriptions should be conducted for the purpose of developing guidelines for future OO behavior description efforts.

6. **BENEFITS TO ARMY**: There is a growing need for advances in techniques and methods for semi-automated representation of friendly and opposing forces within Advanced Distributed Simulation (ADS). Force modernization has caused an evolution in the tactics and doctrine of friendly and opposing forces. In addition, the focus has shifted from a large monolithic force to forces supporting more regional threats. These events have created a situation where existing battlefield behaviors within simulations must be modified and new battlefield behaviors must be created in a timely manner. This is particularly challenging as the specifications for behaviors are costly and time-consuming to develop, and once specified, implementation of those behaviors is labor intensive. Composeable Behavior Technology provides a cost-effective methodology for evolving and developing foreign Semi-Automated Forces (SAF) behavior, reducing the manpower required to represent foreign behaviors, and creating a repository of reusable behaviors.

7. **WORK REMAINING TO BE COMPLETED**: STRIMCOM/SAIC will continue the development of the primitive and predicate behaviors with NGIC and TRAC SME review. The operation of the behaviors will be demonstrated in a ModSAF scenario and the behavior set will be refined as necessary based on validation by the SMEs. The validated behaviors will be added to the CBT behavior repository. A final report will be generated and that and the software will be made available to MODSaf and CBT users.

   In order to increase awareness of this capability, STRICOM/SAIC is preparing a paper for presentation at a number of forums such as the Standards Interoperability Workshop (Mar 00) and the Computer Generated Forces Conference (May 00) and other appropriate venues.

8. **SCHEDULES WITH MILESTONES**:

ACTION	**% COMPLETE (As of 6 Aug 99)**	**SCHEDULE/MILESTONE (completion date)**
Task Analysis	100	
Implementation	50	6 Oct 99
Develop Primitives/Predicates	65	13 Sep 99
Demonstrate Behavior	0	13 Sep 99
Refine Primitives/Predicates	0	6 Oct 99
Integration and Testing	0	10 Dec 99
Assessment of Results	0	12 Jan 00
Deliver Final Report	0	18 Feb 00
Deliver Software	0	18 Feb 00

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FY99 AMIP and SIMTECH STEWARDSHIP REPORT

1. **PROJECT TITLE:** Standardization of Simulation ABCS Interfaces

2. **PROJECT ID:** SIM–99-ODCS4-01

3. **SPONSORING AGENCY:** ODISC4

4. **ACCOMPLISHMENTS:**

   a. SIMTECH funds were used to augment the work being performed under STRICOM’s Warfighters’ Simulation (WARSIM) 2000 contract for developing a common Modeling and Simulation (M&S)/Army Battle Command System (ABCS) tactical messaging interface. The Defense Information Infrastructure (DII) Common Operating Environment (COE) Message Processor (CMP) was utilized to support the development of this interface. The CMP is being developed by Project Manager (PM), Army Tactical Command and Control System (ATCCS), and provides an automated, multi-functional, message-processing system designed to enhance data interoperability between Department of Defense (DoD) Command, Control, Communications, Computers, and Intelligence (C4I) systems. The CMP contains state-of-the-art technology to process both inbound and outbound messages using a standard Graphical User Interface (GUI). The design is based on the leading-edge technology inherent in the Joint Automated Message-Preparation System (JAMPS), which was developed by the Air Force with participation by the Army and Marine Corps. The CMP performs validation of inbound and outbound messages, data extraction from messages, message formatting, and message normalization. The CMP processes incoming messages using Message Text Format (MTF) tables derived from the Joint Interoperability Engineering Office (JIEO) Central Data Base System (CDBS). The CMP is used to parse and format several organic C4I system message formats to include United States Message Text Formats (USMTF) and Variable Message Formats (VMF).

   b. The WARSIM C4I Computer Software Configuration Item (CSCI) contractor support team has evaluated the CMP and established “simulation specific” CMP requirements, so that appropriate enhancements could be made to better accommodate simulation needs for supporting simultaneous, bi-directional, interfaces to multiple C4I systems at various echelons of command. Initially the WARSIM C4I CSCI contractor support team evaluated a UNIX-based CMP with limited functionality. This evaluation lead to simulation specific requirements to include: bi–directional messaging, multi-threaded messaging, automatic message formatting, the accommodation of multiple instantiations of CMP on a single platform, and support of parsing for C++ and Java data structures. These simulation specific requirements led to the development of a Java version of the CMP which provided significant improvements over the UNIX-based version with respect to meeting simulation needs. The Java version of the CMP has been integrated and tested as part of the WARSIM C4I Interface. To date the refined CMP product has been used to parse and format specific organic USMTF messages to provide two way communications between WARSIM and the following ABCS systems: Maneuver Control System (MCS) and the All Source Analysis System (ASAS) - Remote Workstation (RWS). In the near future enhancements will be made to the WARSIM C4I Interface to provide two way communications between WARSIM and the Advanced Field Artillery Target Data System (AFATDS), Combat Service Support Control System (CSSCS), and Air and Missile Defense Workstation (AMDWS) using USMTF, VMF, and other message formats. The messages identified in the following table have been supported to date.

Message	Description	C4I System	System Interface[Note 1]
USMTF S303	Size, Activity, Location, Unit, Time, Equipment (SALUTE) Report	· MCS · ASAS-RWS	· Objective WARSIM System (Build 0.1) · WARSIM Integration Systems Prototype (ISP)
USMTF S309	ENEINTERMSG …Enemy Interoperability	MCS	Objective WARSIM System (Build 0.1)
USMTF S201	GEOMETRY …Battlefield Geometry	MCS	Objective WARSIM System (Build 0.1)
USMTF S302	FREETEXT …Free Text Message	MCS	Objective WARSIM System (Build 0.1)
USMTF S507L	RESOURCES(L) …Unit Location	MCS	Objective WARSIM System (Build 0.1)
USMTF S507R	RESOURCES(R) …Resource Location	MCS	Objective WARSIM System (Build 0.1)
USMTF S507S	RESOURCES(S) …Supply Point Data	MCS	Objective WARSIM System (Build 0.1)
USMTF A423	Order	MCS	Objective WARSIM System (Build 0.1)
USMTF C111	TACREP	ASAS-RWS	WARSIM ISP
USMTF C110	Intelligence Report	ASAS-RWS	WARSIM ISP

Note 1: Interface software for the objective WARSIM system supports "two way" communications between the simulation and the indicated C4I systems. Interface software for the WARSIM Integrated Systems Prototype (ISP) is primarily "one-way" from the simulation to the indicated C4I systems. The WARSIM ISP C4I Interface has been primarily used to gain insights associated

with sending simulation data to the target C4I systems, performing the necessary translation services such that the native formats understood by these C4I systems are provided. In cases where WARSIM ISP C4I interface software is utilized for the objective WARSIM system, a “two-way” implementation of the message set is (or will be) provided.

Note 2: The WARSIM objective system (Build 0.2) is currently under development. Additional development on the WARSIM ISP is also being performed (addressed in paragraph 7 below).

c. The WARSIM C4I CSCI contractor support team has participated in prototyping, testing, and evaluating the Java version of the CMP. During this evaluation, it was determined that enhancements to the WARSIM C4I Interface would be required before the CMP could be effectively used to support translation services. The CMP provides the capability to produce Java objects, but the objects produced were found to be too generic for direct use in supporting translations between native C4I and simulation data formats. The data contained within CMP objects are captured as strings -- similar in concept to a hash table with the field names, sets, and segments utilized as the hash table keys. During the evaluation process, the WARSIM C4I contractor support team determined that an additional level of resolution would be required to effectively support translations between native C4I and simulation data formats using the CMP. To address this challenge, software was developed which utilized template Message Text Format (MTF) objects generated by the CMP to produce MTF classes. It is noted that even though the MTF Class Generator produces Java classes from the CMP objects, those classes still rely upon the CMP for the parsing and formatting of message data. The MTF class acts like a wrapper around the CMP object. Any Application Programmers Interface (API) calls to “set” or “retrieve” data from the MTF class are forwarded to the underlying CMP object.

When MTF classes are instantiated with message data, the following API calls to the CMP are utilized to parse the incoming data:

1) int MtfObject:getID() --returns the ID of this object
2) String MtfMessage:getMsgNumber() -- returns message number (e.g.: A423, S507…)
3) String MtfObject.getName() -- returns name of this object
4) MtfField MtfFieldGroup:getField(int index) -- return specified field from field group
5) MtfSet MtfField:getParentSet() -- returns set containing this field
6) Vector MtfSet:getFieldAlternates(int fieldID) -- returns list of alternates for a given field
7) Boolean MtfObject:isRepeatable() -- returns true if this object is repeatable
8) MtfObject MtfBody:getFirstObject() --returns first child of this object

9) Short MtfObject:getOccurrence() --returns the occurrence of this object (maintained for repeating objects)
10) String MtfObject:getData() - - returns data contained in this object
11) MtfObject MtfBody:getNextObject(MtfObject currObj) -- returns next child after currObj

When MTF classes are converted to strings, the following API calls to the CMP are utilized to format the outgoing data:

1) int MtfObject:getID() --returns the ID of this object
2) String MtfMessage:getMsgNumber() -- returns message number (e.g.: A423, S507…)
3) String MtfObject.getName() -- returns name of this object
4) MtfField MtfFieldGroup:getField(int index) -- return specified field from field group
5) MtfSet MtfField:getParentSet() -- returns set containing this field
6) Vector MtfSet:getFieldAlternates(int fieldID) -- returns list of alternates for a given field
7) Boolean MtfObject:isRepeatable() -- returns true if this object is repeatable
8) MtfSet MtfMessage:insertUnscheduledSet(String setName, MtfSet currSet, boolean createFields) --inserts unscheduled set after currSet
9) JmpsApp:createMsgTemplate(String msgID, String msgNum, String baseline, boolean createFields) -- creates template CMP object for given message/baseline
10) MtfSet MtfBody:getFirstSet() -- returns first set in this message
11) MtfObject MtfObject:getObject(String mtfType, short mtfSequence, short occurrence) -- returns the object that is of mtfType, sequence, and occurrence
12) MtfObject MtfObject:createTemplateObject(boolean fillMandatory, boolean createFields, boolean insertObject) --creates new instance of this object (used for repeating objects)
13) Void MtfObject:setData(String data) -- populates this object with data
14) Void MtfObject:fillMandatoryObjects(boolean mandatorySetsOnly, boolean emptySetsOnly) --populates empty/mandatory sets with '-'
15) String MtfMessage:getMessageText() -- returns string representation of MtfMessage instance.

Other CMP APIs utilized for creating C4I Classes include the following:

1) JogsMessageIndex JmpsApp:getMessageList(String baseline) -- returns instance of JogsMessageIndex for a given baseline.
2) Int JogsMessageIndex:getNumMsgs() -- lists number of messages supported by CMP for a given baseline.
3) Int JogsMessageIndex:getMessageNumber(int index) -- returns message number.
4) String JogsMessageIndex:getMessageName(int index) --returns message name.
5) JmpsApp:createMsgTemplate(String msgID, String msgNum, String baseline, boolean createFields) -- creates template CMP object for given message/baseline
6) MtfObject MtfObject:getFirstObject() -- returns first child object
7) Boolean MtfObject:isRepeatable() -- true if object is repeatable

8) MtfObjet MtfObject:getNextObject() -- returns next child object
9) MtfSet MtfMessage:getSetDefinition(short sequenceNum, boolean createFields) --(used to create unscheduled sets: AMPN, NARR, RMKS, and DECL)
10) Vector MtfField:getCodeList() -- returns list of valid codes for field
11) MtfSet MtfField.getParentSet() -- returns parent object that contains this field
12) String MtfObject:getName() -- returns the name of this object
13) int MtfObject:getID() --returns the ID of this object
14) String MtfOBject:getName() -- returns name of this object

d. A Mapper Generation Tool was developed to support the translation services between organic USMTF message formats and the “simulation friendly” Command and Control Data Interchange Format (C2DIF). The primary function of the WARSIM C4I Interface is to provide the “end-to-end” connection and translation services between organic C4I equipment (utilized by the Training Audience (TA)) and the C2DIF. C2DIF is the Joint Simulation System (JSIMS) Alliance standard for communication between the JSIMS simulation components (of which WARSIM is one) and organic C4I equipment. C2DIF provides the WARSIM/JSIMS simulation object oriented representations of C4I messages which are developed from basic building blocks of information derived from organic command and control messages. By decomposing the information contained within organic messages into basic building blocks of information, multiple sets of organic messages that have similar content (even if differing in format) can be mapped to similar C2DIF representations. The translations between simulation and tactical message formats are accomplished via a pseudo "data driven" approach -- the "data" is actually compiled source code utilized to perform the translation function. These established relationships accommodate “two way” message translation for the sets of organic C4I messages being supported by WARSIM. The Mapper Generation Tool is a stand alone executable that is used during the pre-exercise phase to perform the message "mapping" functions. The current implementation of the Mapper Generation Tool utilizes a tree structure for representing the loaded interactions. As it matures, the Mapper Generation Tool will move towards a “drag and drop” approach to building Mapping files. The source code based mapper approach accommodates "mapping" for multiple versions of tactical messages (for example, USMTF 93, 95, 98, 99+, 2000, etc. -- all of which are separate baselines) to a common simulation format, and vice versa. It also allows new "mappings" to be created when tactical message formats change without the need for modifying or recompiling the core WARSIM C4I Interface executable code. As indicated previously, the WARSIM C4I Interface Mapper Generation Tool is comprised of classes which perform translation mappings by generating source code. It is noted that C4I interfaces of the past generally utilize mapping tables and other “data driven” approaches to perform translation services, primarily in the attempt to better isolate these interfaces from changes in organic C4I messages (thus avoiding the need to recompile when mapping data changes). In contrast, the WARSIM C4I Interface utilizes Java’s Class-Loading capability such that classes can be dynamically loaded without the need for recompilation. Thus various mapping data can be loaded as necessary without affecting the WARSIM C4I Interface.

It is noted that JSIMS initially evaluated the Command and Control Simulation Interface Language (CCSIL) as a potential C4I simulation language candidate, but concluded that CCSIL was not well-suited for use in the form that existed at that time for the following reasons:

- CCSIL was not being maintained
- CCSIL consisted of C data structures, and was not Object Oriented. Thus CCSIL would not readily enable JSIMS to take advantage of object oriented design (OOD) features for data provided/consumed by the simulation, or enable JSIMS to take advantage of OOD features for supporting translation services between the simulation components and organic C4I equipment.

Multiple military organizations are currently participating in defining C2DIF for the C4I messages being supported for JSIMS. WARSIM has utilized C2DIF to provide basic building blocks for various C4I Messages. This has enabled a significant amount of software re-use for accommodating multiple Army Messages.

e. The WARSIM ISP was developed, and has been utilized to support ABCS testing at the Consolidated Test Support Facility (CTSF) in Fort Hood, TX. The WARSIM ISP provides a low overhead simulation/C4I driver, and has been extremely effective in supporting these tests. This is primarily because the focus of ABCS testing at the CTSF is on horizontal integration between the various ABCS components (e.g., messaging between MCS and ASAS-RWS). The CMP is the primary means being utilized by the Army to accomplish this horizontal integration. The use of the same CMP within the WARSIM C4I Interface greatly facilitates ABCS testing, because the same identical messages being supported for the ABCS systems (to include support of multiple baselines) can be supported by the WARSIM C4I Interface.

5. **LESSONS LEARNED:** Prototyping and constant contact with C4I community is absolutely essential to ensure successful integration. Prototyping enabled the WARSIM C4I CSCI contractor support team to determine that CMP could not be used “off the shelf” for supporting simulation needs. Simulation specific requirements had to be developed and incorporated, and in some cases simulation software developed to enable successful use of the CMP.

Supporting ABCS testing with the WARSIM ISP at the Fort Hood CTSF has provided the WARSIM program with valuable ABCS system insites, and has enabled the WARSIM program to effectively experiment with C4I system interfaces prior to performing formal development activities for these interfaces.

6. **BENEFITS TO ARMY:**

- The WARSIM C4I Interface provides a common M&S/ABCS tactical messaging interface which has improved interoperability between simulations and C4I systems, and has enabled effective testing of C4I systems.

- Embedding the CMP as part of the WARSIM C4I Interface will allow it to evolve as C4I systems evolve. The WARSIM C4I interface will readily accommodate future modifications as the simulation and/or C4I systems evolve, and will enable support of several message formats and multiple baselines. Thus, older C4I system versions can be supported as well as later ones so long as the message formats are supported by CMP, and the message mappings have been created.

- One of the most significant hurdles to providing effective interfaces between simulations and C4I systems have been the separate paths that the simulation and C4I communities have historically followed. By utilizing CMP to support WARSIM's C4I Interface, significant strides have been taken to merge these communities, increase awareness between them, and better facilitate C4I/simulation interoperability.

7. **WORK REMAINING TO BE COMPLETED:**

- Development of WARSIM ISP enhancements such that it will be in a better position to support ABCS 6.0 testing at the CTSF. Enhancements will include messaging for AFATDS, CSSCS, and AMDWS.

- Development of a Technical Paper for the Fall 99 Simulation Interoperability Workshop (SIW) and presenting findings at the SIW event which address the WARSIM C4I Interface Effort using CMP.

- Continuing WARSIM ISP prototyping and CTSF related efforts to support the development of the WARSIM objective system.

The CMP has been incorporated into the WARSIM development baseline for message processing. Team WARSIM expects to continue working with CMP throughout it's development cycle.

8. **SCHEDULES WITH MILESTONES:**

- May 98 -- CMP Evaluation (UNIX-based product)
- Jul 98 – Installation of WARSIM ISP at CTSF
- Aug 98 -- CMP M&S Requirements (1st iteration)
- Oct 98 – Initial release of Java-based CMP (version 2.0.0.1)
- Oct 98 beta testing and evaluation of Java-based CMP (version 2.0.0.1) drop
- Feb 99 – WARSIM ISP used to support ABCS 4.1.2 Preliminary Testing

- Feb-Mar 99 -- Contract "Turn-on" for initial SIMTECH effort (ISP AFATDS "add-on")
- Apr 99 -- Integration of Java-based CMP (version 2.0.0.1) into WARSIM C4I Interface
- Jun 99 -- updates to version 2.0.0.1 release of Java-based CMP
- Jun 99 -- Contract "Turn-on" for Phase I SIMTECH CTSF support effort
- Jun 99 – WARSIM ISP2 used to support ABCS 4.3 Testing
- Aug 99 -- Contract "Turn-on" for Phase II SIMTECH CTSF support effort
- Sep 99 – Completion of WARSIM ISP3 enhancements for support of ABCS 6.0 testing
- Oct/Nov/Dec/Jan 99 – Use of WARSIM ISP3 to support ABCS 6.0 testing
- Aug 99 – Delivery of CMP version 4.0.0.1 from Unixpros to PM ATCCS to DISA
- Aug 99 – Development of a Technical paper addressing WARSIM C4I Interface Effort using CMP for Fall 99 SIW
- Sep 99 – Presentation of WARSIM C4I Interface Effort using CMP at Fall 99 SIW
- Oct 99 – Target release of CMP version 4.0.0.1 by DISA (probably will release as version 4.1.0 or something similar)
- Mar 2000 – Completion of SIMTECH Phase II effort.

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FY99 AMIP and SIMTECH STEWARDSHIP REPORT

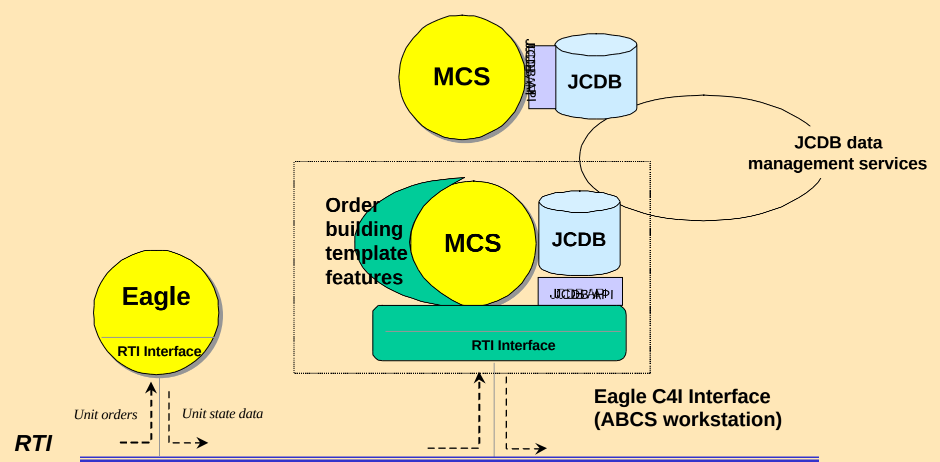
1. **PROJECT TITLE**: Simulation/Stimulation Research and Development

2. **PROJECT ID**: SIM-99-TRADOC-01

3. **SPONSORING AGENCY**: TRADOC

4. **ACCOMPLISHMENTS**:

The objective of the effort has been to develop a prototype of a reusable C4I interface FOM containing a meaningful set of data elements which support data exchanges between Army tactical C4I systems and Army combat simulations. A schematic of the prototype follows.



Proposed EAGLE JCDB Federation Diagram

- Received prototype of JCDB from PEO C3S. Began experimentation with integrated JCDB API. Difficulties getting the software loaded and operational has delayed efforts to test C4I interface software.

- Developed concept for interface to JCDB and briefing to technical review panel in Orlando in March.

- Developed draft Federation Object Model (FOM)

FY99 AMIP and SIMTECH STEWARDSHIP REPORT

- Developed draft Simulation Object Model (SOM)

- Briefed draft FOM and SOM to technical review panel in July. Provided draft FOM and SOM to AMSO and SMDC.

5. **LESSONS LEARNED:**

6. **BENEFITS TO ARMY**: Work directly led to briefing for DUSA-OR which resulted in directive to establish a Sim/Stim IPT under joint STRICOM and NSC leadership. This IPT will oversee the transition to standardized interfaces that will save the Army money in the reduction of effort on several non-standard approaches. The potential long term cost saving has been estimated at $6M. While conserving resources, this effort will lead to development of a more robust interface permitting the enhancement of training and analysis model functionality.

7. **WORK REMAINING TO BE COMPLETED**: Completion of prototype products and reports.

8. **SCHEDULES WITH MILESTONES**: This work should be completed during 1st quarter, FY 00.

9. **POINTS OF CONTACT**:

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FY99 AMIP and SIMTECH STEWARDSHIP REPORT

1. **PROJECT TITLE:** Intelligent Agent Based OPFOR

2. **PROJECT ID:** SIM-99-TRADOC-02

3. **SPONSORING AGENCY:** Command Decision Modeling SCC, National Simulation Center, TRADOC.

   PROJECT AGENCY: Jet Propulsion Laboratory, NASA

4. **ACCOMPLISHMENTS**:

   - In coordination with CECOM and JPL, NSC has expanded the scope of the project. The CECOM matching funds have allowed us to include the objectives of porting the Smart Enemy Agent software to NT, linking it to our MACE environment, and integrating the JPL and MACE work with complementary CECOM software developments.
   - JPL has developed a modeling framework for a Simulation Environment for Rapid Prototyping ENemy Tactics (SERPENT) based on:
     - computational electrostatics
     - embedded inline constructive simulation capability (currently CBS)
     - dataset representation
     - enemy template representations based on NSC SME input
     - CECOM, JPL and NSC have established a coordinated information-exchange program of regularly scheduled teleconferences and face-to-face meetings to use the available resources more efficiently.

5. **LESSONS LEARNED:** Achieving credible realism with very few controllers in an easy-to-use and understand, fast-running division/corps simulation environment will require a state of the art user interface, advances in smart agent software technology, and simple--but believable—algorithms for the underlying movement, attrition and consumption processes.

6. **BENEFITS TO ARMY**: Development of a one-to-five person(s), user-friendly, graphically-oriented division/corps prototype wargaming environment useable for:
   - student training
   - autonomous assessment of human-generated Courses of Action (COAs) testing algorithms and automated command decision software

   Reduction in the number of human-in-the-loop Opposing Force controllers at simulation driven exercises which will use future simulations such as JSIMS, WARSIM 2000, and OneSAF.

   Leveraging stable fusion algorithms developed by JPL, CECOM-sponsored research efforts, and NSC-developed simulation prototyping environment for maximum results at low cost.

Successful completion of this project will provide the basis for a viable low-overhead driver component. A Low-overhead Driver will stimulate C4I devices and provide inexpensive staff training.

7. **WORK REMAINING TO BE COMPLETED**:
   - Port existing SERPENT agent software to NT platform
   - Link JPL agent software with NSC-developed simulation prototype environment
   - Agents will be provided for Latin America and Korea theaters with roles Movement, Attack, Artillery, and Engineer, using battalion, company, and platoon.
   - Increase the fidelity of the underlying simulation based on established algorithms.
   - Integrate agent software capability.
   - Develop Human User/Software Agent cooperation capability.

8. **SCHEDULES WITH MILESTONES for FY2000**:

July 1998:	Demo of Agent Software on Sun with CBS
Oct 1999:	Port Existing Agent Software to NT Environment
Jan 2000:	Installation and Integration of Oracle with Agent Software
	Integration of Agent/Oracle with MACE
	Armor Movement in Attack Formation in Korea Scenario

9. **POINT OF CONTACT**:

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